Using Spectroscopy to Design New Types of Solar Cells

F. J. Himpsel
Physics Department, University of Wisconsin Madison

Solar cells are the ideal solution to the energy problem, converting abundant solar energy directly into electricity, which is fully convertible into all other types of energy. An area of 100×100 square miles is sufficient to satisfy the electricity needs of the US with currently available solar cells. But that would cost about a trillion dollars.

This talk illustrates how spectroscopy with soft X-rays can assist the development of new materials and new designs for solar cells with better price/performance ratio. The starting point is the most general layout of a solar cell, which consists of a light absorber sandwiched between an electron donor and an electron acceptor. The relevant energy levels can be measured by a combination of X-ray absorption spectroscopy and photoelectron spectroscopy [1]. Examples for the design process will be given, such as organic dyes as absorbers, p-doped diamond films as inert donors, and the combination of all three components in one molecule (donor-π-acceptor complexes [2]). In order to speed up the development of new solar cells, a feedback loop is currently being established between spectroscopy, theory, synthesis, and device fabrication/testing.

[1] F. J.Himpsel et al., J. Electron Spectrosc. Relat. Phenom., published online (2012).
http://dx.doi.org/10.1016/j.elspec.2012.10.002

[2] A. Yella, H.-W. Lee, H. N. Tsao, C. Yi, A. K. Chandiran, Md. K. Nazeeruddin, E. W.-G. Diau, C.-Y. Yeh, S. M. Zakeeruddin, M. Grätzel, Science **334**, 629 (2011).